

Capacity Building Series

K-12

SPECIAL EDITION #28

A Call to Action

"Just as literacy has become every teacher's responsibility, so numeracy needs to be seen as integral to every learning area."

(Thornton & Hogan, 2004, p. 313)

Supporting Numeracy

Building a Community of Practice K-12

Mathematics is everywhere and its importance grows exponentially. Researchers in fact describe numeracy skills as a "new currency of modern societies around the world" (OECD, 2010, p. 33). In large and small aspects of daily life – from understanding election results to developing a business plan to managing a household – we rely on mathematical data, projections, inferences and systematic thinking. That is why numeracy – like literacy – is considered so fundamental. Whether the call to action is "mathematical literacy," "quantitative literacy," "everyday math" or "numeracy," our challenge as K to 12 educators is to help prepare all our graduates to apply mathematics in the context of their everyday world.

This monograph has been developed to support the Ontario conversation about numeracy – to spark dialogue and debate on how to develop a mathematical habit of mind, not just for students but for educators as well, to move the math beyond the walls of the mathematics program to teaching and learning across the curriculum and across the day.

About Numeracy and Mathematics

Numeracy and mathematics share an inherent relationship. On the one hand, skills like critical thinking and problem-solving, applying technology and understanding data require "a solid grounding in mathematical concepts and procedures. On the other hand, knowledge of mathematical concepts and procedures alone is not enough to guarantee numeracy" (State of Victoria Department of Education and Early Childhood Development, 2009, p. 6). Some researchers suggest it is helpful to think of mathematics

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Finding new ways to work together:

"In order for our efforts with numeracy to be realized within K–12, we will need to find different ways to work with teachers to address matters of content knowledge, classroom pedagogy, resources and assessment."

(Friesen, 2003, p 2)

Consider:

- How might we develop a shared understanding of what it means to be numerate?
- Do we have a shared understanding of what numeracy will mean for our students' future success?
- Do we have a shared understanding of the role of numeracy across the subjects/disciplines?
- How might our team collectively build on the mathematical capacities of our students so that they become confident, innovative problem-solvers in a variety of situations?
- How might we create an environment where teachers and students alike are active learners of mathematics?
- How might we create an environment where all educators are responsible for numeracy development?

as "a well-established discipline" and numeracy as "necessarily inter-disciplinary." Steen suggests that "numeracy, like writing, must permeate the curriculum." When it does, "it will enhance students' understanding of all subjects and their capacity to lead informed lives" (Steen, 2001, p. 115).

Creating a School-wide Numeracy Culture

It takes ongoing, intentional work to create and sustain a school culture that recognizes, emphasizes and reinforces a cross-curricular approach to numeracy. As teams explore a school-wide capacity-building approach to numeracy, they are not expected to replace the special expertise of the mathematics teacher but to encourage their colleagues to highlight the math in all subject domains: Victoria, Australia has taken this approach, encouraging "the liaison between teachers of mathematics and other school staff" as a way to foster "complementary learning" (2009, p. 57). While mathematics teachers have the primary responsibility for developing students' mathematical understanding, all teachers can work together to address the mathematical learning across the disciplines and across the day.

Applying the Math

Numeracy is about doing the math – about recognizing and using mathematics – in a variety of contexts that range from the everyday to the unusual; it's about being able to use mathematics as a tool to explore problems and situations. There is a vast array of opportunities to explore numeracy in the curriculum in every subject area. A problem such as the one outlined below allows students to engage in numeracy skills within the science and the physical education and health curriculum.

"When teaching mathematics is seen as a way of teaching people how to think," writes Joan Richards, "its implications spread throughout the curriculum and it has a place in every class" (2001, p. 36). OECD researchers use the term "authentic" to describe using mathematics to genuinely solve a problem as opposed to using it as a "vehicle for practising some mathematics" (2006, p. 81). Here is one example of an authentic problem (adapted from the 2006 Programme for International Assessment [PISA]):

For many years, the relationship between a person's recommended maximum heart rate and that person's age was described by the following formula:

Recommended maximum heart rate = $220 - \text{age}$

Recently the formula has been modified. The new formula is as follows:

Recommended maximum heart rate = $208 - (0.7 \times \text{age})$

a) How does the new formula impact the calculation of recommended maximum heart rate?

b) Why do you think the formula was modified?

You may wish to try solving the heart rate problem, noting the many ways that your colleagues approach the solution.

Focusing on the Instructional Core – Developing Numeracy across the Curriculum

The following three considerations – (1) real-life context, (2) mathematical content knowledge and (3) mathematical processes – allow educators to plan a wide array of experiences related to numeracy across the curriculum.

You can work through the considerations using the heart rate problem or you may prefer to use another real-life problem.

1. Real-life context

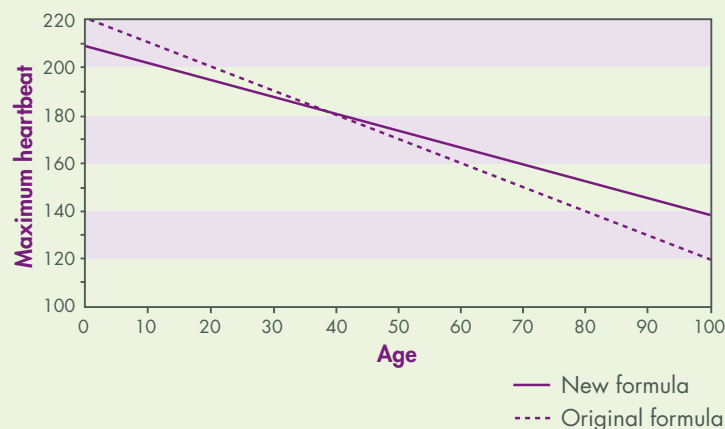
Students require ongoing opportunities to apply mathematics to both familiar and unfamiliar situations in order to develop a mathematical habit of mind. A student's personal or school life, his or her work or leisure life or his or her involvement in the community or even society at large are all domains that can be considered as "situations" of real life context (Steen, 2001). Greater connections to these domains lead to greater relevance and engagement for the student.

The heart rate problem affords students a real-life context – their health and well-being – to think mathematically.

2. Mathematical content knowledge

When their content knowledge is "more explicit, better connected and more integrated," educators teach with more confidence, represent the subject more richly and are more open to students' questions and comments. When their knowledge is more limited, they tend to "de-emphasize interactive discourse in favour of set work assignments, and in general, portray the subject as a collection of static, factual knowledge" (Brophy, 1991, p.352). As part of the call to action for mathematical literacy, we need to be open as educators to pulling apart and unpacking the mathematics our students will be encountering in subjects and courses across the day.

The heart rate problem affords students an opportunity to think about the larger ideas of change and relationships. In part (a) of the problem, for example, students are asked to evaluate two formulas about the proportional relationship between heart rate and age. There are a number of ways to think through the formulas. One way is to use a graph to represent the formulas and then compare them.



By returning the problem to its real-life context, we can see that the new formula suggests that the recommended maximum heart rate is lower for people under 40 and higher for those over 40.

3. Mathematical Processes

Doing mathematics in context requires a repertoire of cognitive strategies that we can draw on as needed. The repertoire enables us to recognize when mathematics might help us solve a problem or interpret a situation and then select and apply the appropriate mathematics strategy. In the Ontario mathematics curriculum, seven processes are identified as essential for acquiring and applying mathematics. These mathematical processes – (1) problem solving, (2) reasoning and proving, (3) reflecting, (4) selecting tools and computational strategies, (5) connecting, (6) representing and (7) communicating – create the student's numeracy toolkit. Educators will recognize that all of the processes apply to different areas of the curriculum and to real-life situations.

*In the heart rate problem, students can **represent** the relationship between age and heart rate by using a graphing **strategy**. By **connecting** their knowledge of point of intersection they can then **justify** how the new formula impacts the calculation of the recommended maximum heart rate.*

Moving Forward

NEXT STEPS

Numeracy as well as literacy is fundamental to student success.

The process of building a community of numeracy practice requires a collaborative approach; it begins in conversation about how we might support one another in working with students to develop their full potential in mathematics and it leads to further exploration of the numeracy links across disciplines. When we help our students make numeracy connections throughout the day, we are engaging them in understanding the many dimensions of our interconnected world.

Questions for Reflection

- How might research findings support a deeper understanding of mathematics in different contexts?
- How might professional learning time be structured for educators to develop a deeper understanding of mathematical concepts and numeracy connections?
- Are there other members of the community who could be invited to the numeracy conversation?

Equal and Supporting Partners

“Numeracy is not the same as mathematics, nor is it an alternative to mathematics. Rather, it is an equal and supporting partner in helping students learn to cope with the quantitative demands of modern society.”

(Steen, 2001, p. 115)

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